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75th MORSS CD

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A Decision Support System to help Prioritize Sensor Capabilities for Lunar Landers and Planetary Rovers

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A Decision Support System to help Prioritize Sensor Capabilities for Lunar Landers and Planetary Rovers



MORS Symposium
United States Naval Academy
Annapolis, Maryland
11-14 June 2007

MAJ Ernest Y. Wong
Department of Systems Engineering
United States Military Academy



Agenda

- ◆ Background
- ◆ Initial Problem Statement
- ◆ Revised Problem Statement
- ◆ NASA's Approach
- ◆ A Value-Focused Thinking Approach
- ◆ The Decision Support System
- ◆ Additional Applications
- ◆ Conclusions





Background



◆ President Bush's guidance:

"Our goal is to return to the moon by 2020. . . [By] establishing an extended human presence on the moon [we] could vastly reduce the costs of further space exploration, making possible even more ambitious missions."

--January 14, 2004 address to NASA

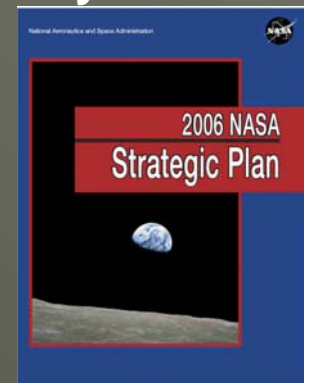


NASA's 2006 Strategic Goals



1. Fly the Shuttle as safely as possible until its retirement, not later than 2010
2. Complete the International Space Station in a manner consistent with NASA's International Partner commitments and needs of human exploration
3. Develop a balanced overall program of science, exploration, and aeronautics consistent with the redirection of the human spaceflight program to focus on exploration
4. Bring a new Crew Exploration Vehicle into service as soon as possible after Shuttle retirement
5. Encourage the pursuit of appropriate partnerships with the emerging commercial space sector
6. Establish a lunar return program having the maximum possible utility for later missions to Mars and other destinations

http://www.nasa.gov/mission_pages/exploration/main/index.html



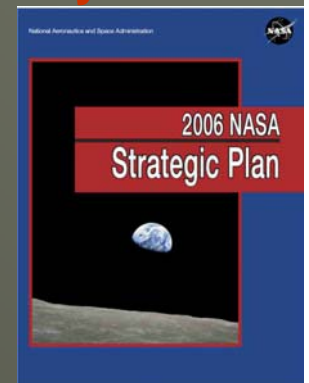


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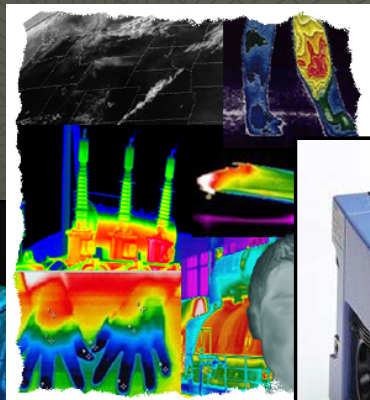
Initial Problem Statement



- ◆ NASA asked us to select the best sensor or sensor suites to improve the safety and reliability of autonomous space exploration
- ◆ Alternative focused thinking approach



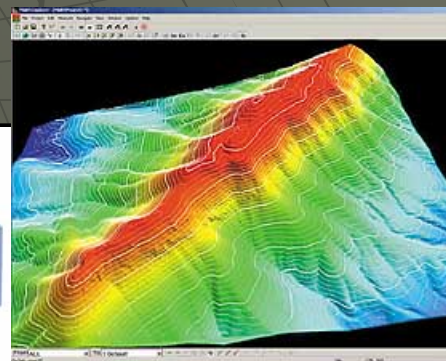
Night Vision



Thermal



LIDAR



Multi-Spectral



Stereoscopic



Video

3D Imaging



Revised Problem Statement



- ◆ Develop a decision support system to help NASA determine which sensor capabilities are most critical for autonomous space exploration
 - The model uses a value focused approach rather than an alternative focused approach
 - The model can be easily modified for varying mission requirements
 - The model segments space exploration into distinct phases in an attempt to capture overall critical mission capabilities

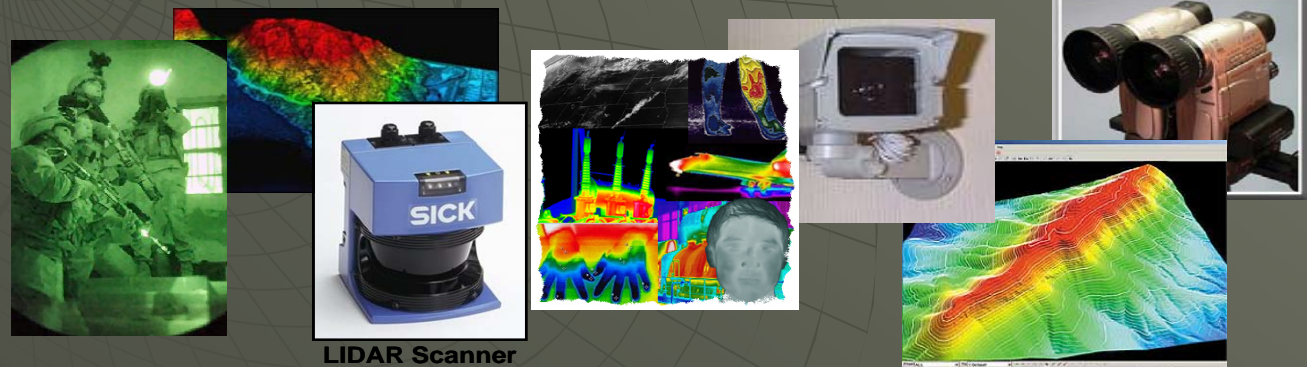




NASA's Current Approach



- ◆ Alternative Focused Thinking (AFT):
 - Focuses on existing solutions to the problem
 - Best sensor suite is limited to what is currently available on an existing list
 - Best sensor suite is also restricted by current technological capabilities
 - A one-size fits all approach that fails to reflect key requirements of any particular mission



LIDAR Scanner



Our Team's Approach



- ◆ Value Focused Thinking (VFT)
 - Values are what people desire
 - Focuses on capabilities of an ideal sensor and the limitations the sensors have to overcome.
 - VFT is markedly different than choosing alternatives and going with the one that fits the best.
 - Focuses an organization's goals and objectives into an action plan





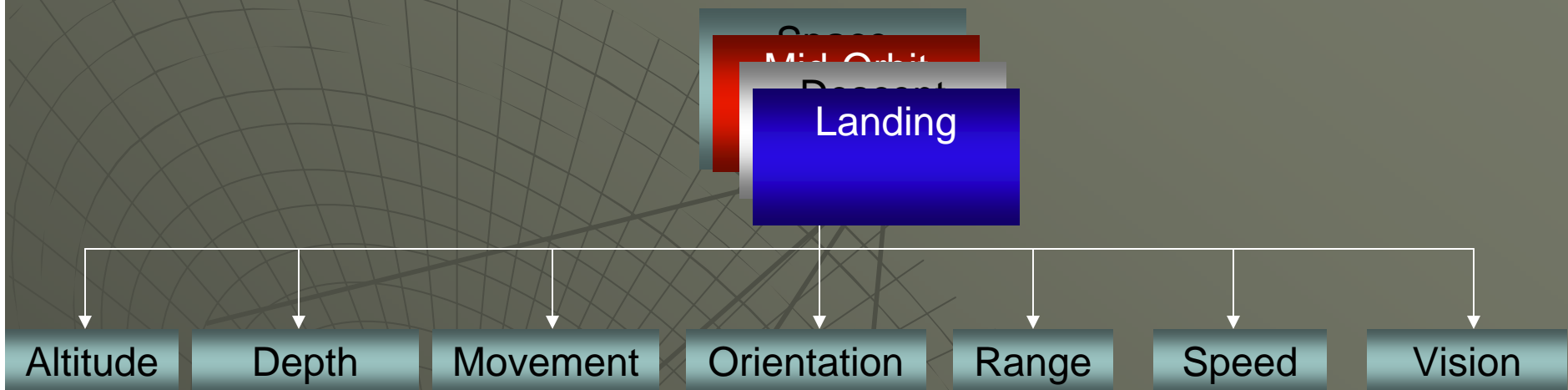
Value-Focused Thinking



- ◆ Ralph Keeney, a pioneer in the field of VFT, introduces the concept of Constraint-Free Thinking:
 - "thinking about values is constraint-free thinking . . . it is thinking about what you wish to achieve or what you wish to have."
- ◆ Provides NASA with a new approach to its research, development and design process
- ◆ Provides NASA with a more unconstrained view of examining what sensor capabilities and requirements it values as being the most critical for future missions



Proposed Functional Hierarchy

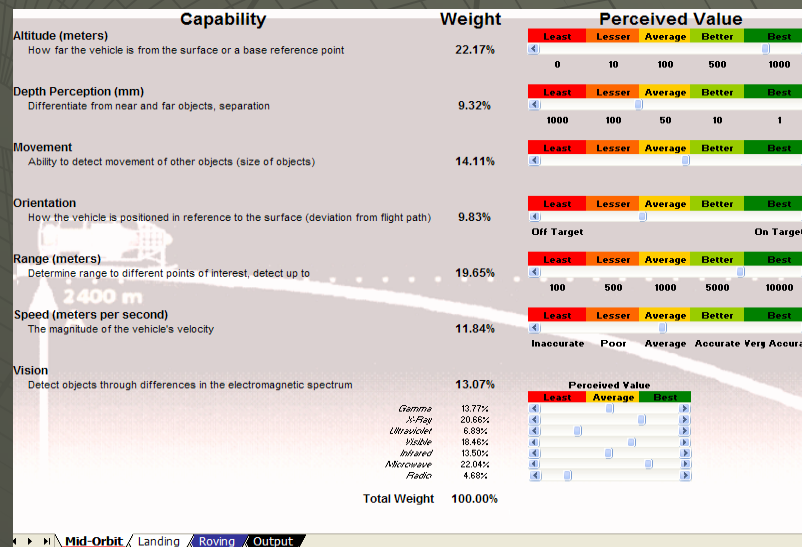




Our Decision Support Model

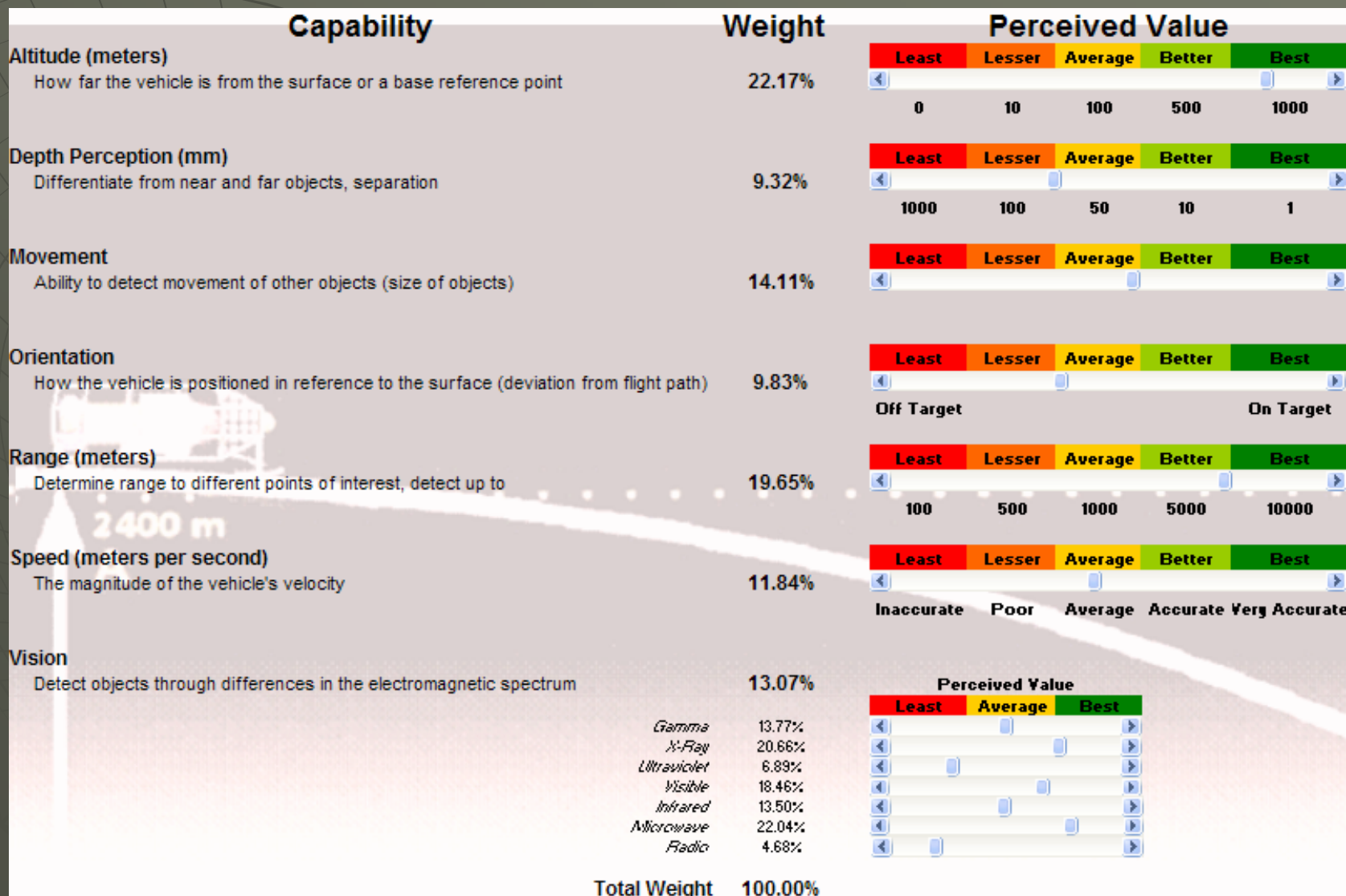


- ◆ A MS Excel Decision Support System (DSS)
 - Makes decisions easier for the stakeholders
 - Links strategy with research
- ◆ Breaks a space mission down into 3 distinct phases: mid-orbit, descent, landing
- ◆ Flexible tool that can be tailored, customized, and adapted to various issues





Demo of the Model





Additional Applications



- ◆ Easily modified for various applications
- ◆ Marine Corps Combat Development Command (MCCDC)
 - Approx. \$20K for a 3rd party to develop a similar product for a Marine Corps Personnel Carrier



Additional Applications

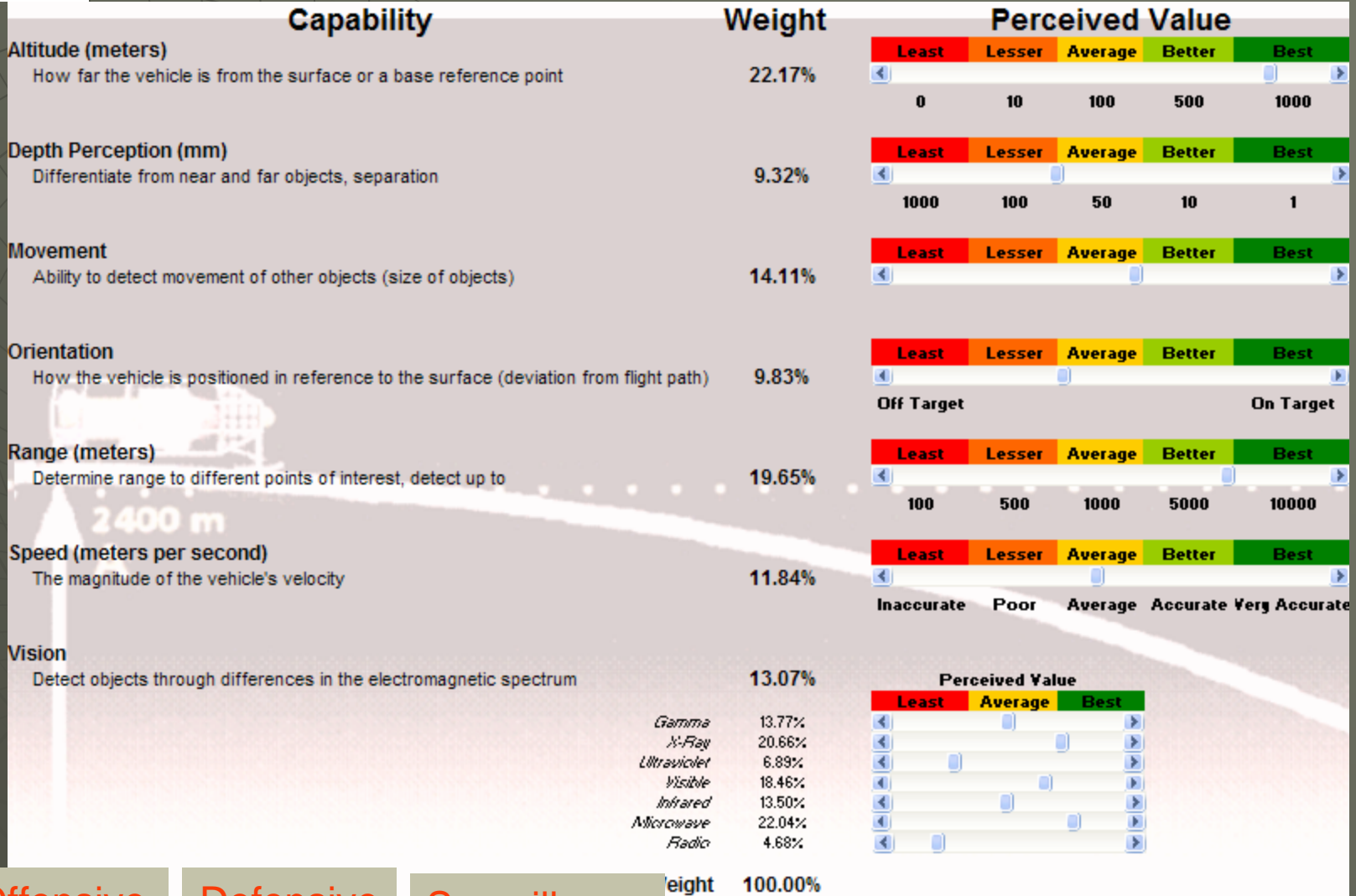


- ◆ Future Weapons Systems
 - Unmanned Ground Vehicle
 - Similar to NASA's rovers





Additional Applications



Offensive
Ops

Defensive
Ops

Surveillance



Conclusions



- ◆ Help identify capabilities and close the gaps for the organization
- ◆ Helps direct R&D funding, more focused approach
- ◆ Provided our stakeholder with a different approach to their problem (value focused as compared to alternative focused)
- ◆ Multi-phase approach vs. single static approach
- ◆ Flexible tool that has multiple applications
- ◆ Sensitivity Analysis
 - Next step in the project



Documentation



- ◆ http://www.nasa.gov/mission_pages/exploration/main/index.html
- ◆ Ralph L. Keeney. (1992). Value-Focused Thinking. Massachusetts: Harvard University Press.
- ◆ Google Images
- ◆ Discovery Channel Future Weapon Systems